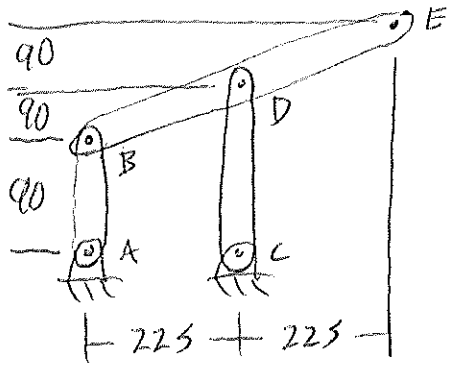
PROB. 15-129



$\omega_{AB} = 6 \frac{RAD}{s}$ ↻ , $\alpha_{AB} = 0$

FIND α_D

VELOCITY

$$\vec{v}_B = \cancel{\vec{v}_A}^{\,0} + \omega_{AB}\hat{k} \times \vec{r}_{B/A}$$

$$\vec{v}_B = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & 6 \\ 0 & 0.09 & 0 \end{vmatrix} = [0 - (6)(0.09)]\hat{i}$$

$$\vec{v}_B = (0.54)\hat{i} \ \frac{m}{s}$$

$$\vec{v}_D = \cancel{\vec{v}_C}^{\,0} + \omega_{CD}\hat{k} \times \vec{r}_{D/C}$$

$$\omega_{CD}\hat{k} \ \vec{v}_D = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & \omega_{CD} \\ 0 & 0.18 & 0 \end{vmatrix} = [0 - (\omega_{CD})(0.18)]\hat{i}$$

$$\vec{v}_D = (-0.18\,\omega_{CD})\hat{i}$$

$$\vec{v}_D = \vec{v}_B + \omega_{BD}\hat{k} \times \vec{r}_{D/B}$$

$$\omega_{BD}\hat{k} \times \vec{r}_{D/B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & \omega_{BD} \\ 0.225 & 0.09 & 0 \end{vmatrix}$$

$$= [0 - (\omega_{BD})(0.09)]\hat{i} - [0 - (\omega_{BD})(0.225)]\hat{j}$$

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$$\omega_{BD}\hat{k} \times \vec{r}_{D/B} = (-0.09\omega_{BD})\hat{i} + (0.225\omega_{BD})\hat{j}$$

$$\vec{v}_D = (0.54)\hat{i} + (-0.09\omega_{BD})\hat{i} + (0.225\omega_{BD})\hat{j}$$

$$\vec{v}_D = (0.54 - 0.09\omega_{BD})\hat{i} + (0.225\omega_{BD})\hat{j}$$

$$(-0.18\omega_{CD})\hat{i} = (0.54 - 0.09\omega_{BD})\hat{i} + (0.225\omega_{BD})\hat{j}$$

X-DIRECTION: $-0.18\omega_{CD} = 0.54 - 0.09\omega_{BD}$

Y-DIRECTION: $\omega_{BD} = 0$

$-0.18\omega_{CD} = 0.54 \Rightarrow \omega_{CD} = -3.0 \ \frac{\text{RAD}}{s}$ ↻

ACCELERATION

$$\vec{a}_B = \cancel{\vec{a}_A}^{\,0} + \cancel{\alpha_{AB}\hat{k}}^{\,0} \times \vec{r}_{B/A} - \omega_{AB}^2 \vec{r}_{B/A}$$

$$\vec{a}_B = -(-6)^2(0.09)\hat{j} = (-3.24)\hat{j} \ \frac{m}{s^2}$$

$$\vec{a}_D = \vec{a}_C + \alpha_{CD}\hat{k} \times \vec{r}_{D/C} - \omega_{CD}^2 \vec{r}_{D/C}$$

$$\alpha_{CD}\hat{k} \times \vec{r}_{D/C} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & \alpha_{CD} \\ 0 & 0.18 & 0 \end{vmatrix} = [0 - (\alpha_{CD})(0.18)]\hat{i}$$

$$= (-0.18\alpha_{CD})\hat{i} \ \frac{m}{s^2}$$

$$-\omega_{CD}^2 \vec{r}_{D/C} = -(-3)^2(0.18)\hat{j} = (-1.62)\hat{j} \ \frac{m}{s^2}$$

$$\vec{a}_D = (-0.18\alpha_{CD})\hat{i} + (-1.62)\hat{j} \ \frac{m}{s^2}$$

PROB. 15-129 CONT.

$$\vec{a}_D = \vec{a}_B + \alpha_{BD}\hat{k} \times \vec{r}_{D/B} - \omega_{BD}^{2^{\nearrow 0}} \vec{r}_{D/B}$$

$$\alpha_{BD}\hat{k} \times \vec{r}_{D/B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & \alpha_{BD} \\ 0.225 & 0.09 & 0 \end{vmatrix}$$

$$= [0 - (\alpha_{BD})(0.09)]\hat{i} - [0 - (\alpha_{BD})(0.225)]\hat{j}$$

$$= (-0.09\alpha_{BD})\hat{i} + (0.225\alpha_{BD})\hat{j}$$

$$\vec{a}_D = (-3.24)\hat{j} + (-0.09\alpha_{BD})\hat{i} + (0.225\alpha_{BD})\hat{j}$$

$$\vec{a}_D = (-0.09\alpha_{BD})\hat{i} + (-3.24 + 0.225\alpha_{BD})\hat{j}$$

$$(-0.18\alpha_{CD})\hat{i} + (-1.62)\hat{j} = (-0.09\alpha_{BD})\hat{i} + (-3.24 + 0.225\alpha_{BD})\hat{j}$$

X-DIRECTION: $-0.18\alpha_{CD} = -0.09\alpha_{BD}$

Y-DIRECTION: $-1.62 = -3.24 + 0.225\alpha_{BD}$

$$\boxed{\alpha_{BD} = 7.2 \ \frac{RAD}{s^2}} \ \curvearrowright$$

$$\alpha_{CD} = \left(\frac{0.09}{0.18}\right)(7.2) \boxed{= 3.6 \ \frac{RAD}{s^2}}$$

$$\vec{a}_D = [-0.09(7.2)]\hat{i} + [-3.24 + 0.225(7.2)]\hat{j}$$

$$\vec{a}_D = (-0.648)\hat{i} + (-1.62)\hat{j}, \quad \theta = TAN^{-1}\left(\frac{1.62}{0.648}\right) = 68.20^\circ$$

$$\boxed{\vec{a}_D = 1.745 \ \frac{M}{s^2} \ \swarrow 68.2^\circ}$$